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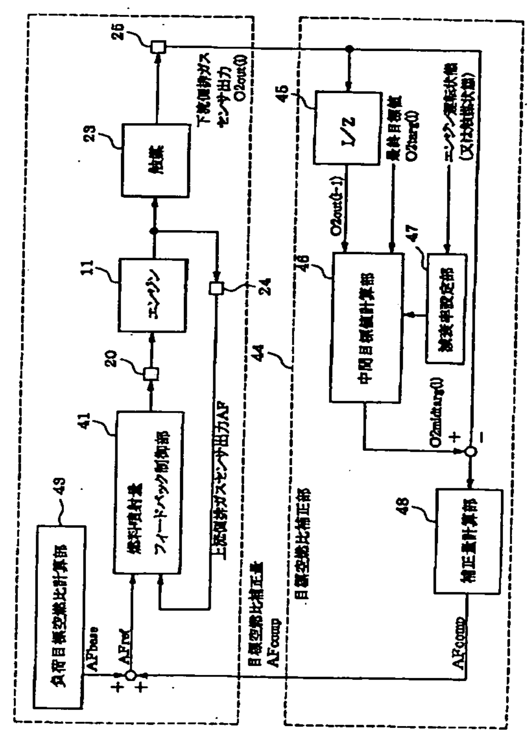
(54)【発明の名称】内燃機関の空燃比制御装置

(57)【要約】
【課題】　中間目標値を用いてメイン／サブフィードバック制御を行うシステムにおいて、内燃機関の運転状態や触媒の状態の変化に応じて適正な制御条件に変更しながら応答性と安定性とを両立させたサブフィードバック制御を行う。
【解決手段】　触媒２３の上流側と下流側にそれぞれ排ガスセンサ２４，２５を設け、前回演算時の下流側排ガスセンサ２５の出力と最終目標値（最終的な下流側目標空燃比）とに基づいて中間目標値を設定し、現在の下流側排ガスセンサ２５の出力と中間目標値との偏差に基づいて上流側目標空燃比の補正量を算出する。この際、排ガス流量又は触媒反応速度に関連するパラメータに応じて中間目標値の更新量、更新速度、サブフィードバック制御の制御ゲイン、制御周期、制御範囲のうちの少なくとも１つを変更する。これにより、運転状態や触媒２３状態の変化に応答良く追従した高応答のサブフィードバック制御を行う。



性能を確保することができない。
【０００７】本発明はこのような事情を考慮してなされたものであり、従ってその目的は、中間目標値を用いてメイン／サブフィードバック制御を行うシステムにおいて、内燃機関の運転状態や触媒の状態の変化に応じて適正な制御条件に変更しながら応答性と安定性とを両立させたサブフィードバック制御を行うことができ、内燃機関の運転状態や触媒の状態に左右されない安定した排ガス浄化性能を確保することができる内燃機関の空燃比制御装置を提供することにある。
【０００８】
【課題を解決するための手段】上記目的を達成するために、本発明の請求項１の内燃機関の空燃比制御装置は、下流側排ガスセンサの過去の検出空燃比と最終的な下流側目標空燃比とに基づいてサブフィードバック制御の中間目標値を設定し、下流側排ガスセンサの検出空燃比と前記中間目標値との偏差に基づいて上流側目標空燃比を補正するサブフィードバック制御を行うものにおいて、内燃機関の運転状態又は前記触媒の状態に関連するパラメータに応じて、前記中間目標値の更新量、更新速度、前記サブフィードバック制御の制御ゲイン、制御周期、制御範囲のうちの少なくとも１つを制御補正手段によって変更するようにしたものである。このようにすれば、内燃機関の運転状態や触媒の状態の変化に応じて適正な制御条件に変更しながら応答性と安定性とを両立させたサブフィードバック制御を行うことができ、内燃機関の運転状態や触媒の状態に左右されない安定した排ガス浄化性能を確保することができる。
【０００９】ここで、内燃機関の運転状態に関連するパラメータとしては、例えば、排ガス流量、吸入空気量、エンジン回転速度、吸気管圧力、スロットル開度、車速、冷却水温、排気温度、アイドルスイッチ信号、始動後経過時間等の中からいずれか１つ又は複数のパラメータを用いれば良く、また、触媒の状態に関連するパラメータとしては、触媒反応速度、触媒温度（排気温度や始動後経過時間等で代替可能）、触媒劣化度合、触媒のO_2ストレージ量（リーン／リッチ成分吸着量）等の中からいずれか１つ又は複数のパラメータを用いれば良い。
【００１０】この場合、触媒による遅れ系（むだ時間と時定数）が排ガス流量や触媒反応速度により大きく変化することを考慮して、請求項２のように、排ガス流量又は触媒反応速度に関連するパラメータに応じて、前記中間目標値の更新量、更新速度、前記サブフィードバック制御の制御ゲイン、制御周期、制御範囲のうちの少なくとも１つを変更するようにすると良い。このようにすれば、触媒による遅れ系（むだ時間と時定数）の変化に応答良く追従した高応答のサブフィードバック制御を安定して行うことができる。
【００１１】また、請求項３のように、下流側排ガスセンサの過去の検出空燃比と最終的な下流側目標空燃比との偏差に減衰率を乗算した値と、最終的な下流側目標空燃比とを加算して中間目標値を求め、内燃機関の運転状態又は触媒の状態に関連するパラメータに応じて減衰率を変更するようにしても良い。このようにすれば、中間目標値を簡単な演算処理で設定できると共に、内燃機関の運転状態や触媒の状態の変化に追従した制御条件の変更を、簡単な演算処理で行うことができる。
【００１２】また、請求項４のように、下流側排ガスセンサの検出空燃比と中間目標値との偏差に対する比例積分動作で演算した値を所定の制御範囲内に制限することで、上流側目標空燃比の補正量を求め、内燃機関の運転状態又は触媒の状態に関連するパラメータ応じて比例積分動作のゲイン（制御ゲイン）及び／又は制御範囲を変更するようにしても良い。このようにすれば、触媒の動特性の変化を上流側目標空燃比の補正量に応答良く反映させることができると共に、内燃機関の運転状態や触媒の状態の変化に追従した制御条件の変更を、簡単な演算処理で行うことができる。
【００１３】
【発明の実施の形態】［実施形態（１）］以下、本発明の実施形態（１）を図１乃至図６に基づいて説明する。まず、図１に基づいてエンジン制御システム全体の概略構成を説明する。内燃機関であるエンジン１１の吸気管１２の最上流部には、エアクリーナ１３が設けられ、このエアクリーナ１３の下流側には、吸入空気量を検出するエアフローメータ１４が設けられている。このエアフローメータ１４の下流側には、スロットルバルブ１５が設けられている。
【００１４】更に、スロットルバルブ１５の下流側にはサージタンク１７が設けられ、このサージタンク１７に、エンジン１１の各気筒に空気を導入する吸気マニホールド１９が設けられている。各気筒の吸気マニホールド１９の吸気ポート近傍には、それぞれ燃料を噴射する燃料噴射弁２０が取り付けられている。また、エンジン１１のシリンダヘッドには、気筒毎に点火プラグ２１が取り付けられている。
【００１５】一方、エンジン１１の排気管２２の途中には、排ガス中のＣＯ，ＨＣ，ＮＯｘ等を浄化する三元触媒等の触媒２３が設置されている。この触媒２３の上流側と下流側には、それぞれ排ガス空燃比又はリッチ／リーンを検出する排ガスセンサ２４，２５が設置されている。本実施形態では、上流側排ガスセンサ２４は、排ガス空燃比に応じたリニアな空燃比信号を出力する空燃比センサ（リニアＡ／Ｆセンサ）が用いられ、下流側排ガスセンサ２５は、排ガスの空燃比が理論空燃比に対してリッチかリーンかによって出力電圧が反転する酸素センサが用いられている。従って、下流側排ガスセンサ２５は、空燃比がリーンの時には０．１Ｖ程度の出力電圧を発生し、空燃比がリッチの時には０．９Ｖ程度の出力電圧を発生する。尚、エンジン１１のシリンダブロックに

タを用いれば良く、また、触媒２３の状態に関連するパラメータパラメータとしては、触媒反応速度、触媒温度（排気温度や始動後経過時間等で代替可能）、触媒２３の劣化度合、触媒２３のO_2 ストレージ量（リーン／リッチ成分吸着量）等の中からいずれか１つ又は複数のパラメータを用いれば良い。

【００２７】本実施形態（１）では、触媒２３による遅れ系（むだ時間と時定数）が排ガス流量や触媒反応速度により大きく変化することを考慮して、減衰率設定部４７は排ガス流量又は触媒反応速度に関連するパラメータに応じて図４のマップ又は数式によって減衰率Kdec を設定する。ここで、排ガス流量に関連するパラメータとしては、吸入空気量、エンジン回転速度、吸気管圧力、スロットル開度等の中からいずれか１つ又は複数のパラメータを用いれば良く、勿論、これらのパラメータから排ガス流量を算出するようしても良い。また、触媒反応速度に関連するパラメータとしては、触媒温度（排気温度や始動後経過時間等で代替可能）、触媒２３の劣化度合、触媒２３のO_2 ストレージ量（リーン／リッチ成分吸着量）等の中からいずれか１つ又は複数のパラメータを用いれば良く、勿論、これらのパラメータから触媒反応速度を算出するようにしても良い。

【００２８】図４の減衰率設定マップの特性は、排ガス流量が少なく（触媒反応速度が遅く）なるほど、減衰率Kdec が大きくなって、中間目標値O2midtarg(i) の更新量が大きくなり、排ガス流量が多く（触媒反応速度が速く）なるほど、ハンチングを防ぐために、減衰率Kdec が小さくなって、中間目標値O2midtarg(i) の更新量が小さくなるように設定されている。尚、減衰率設定部４７は、特許請求の範囲でいう制御補正手段に相当する役割を果たす。

【００２９】以上のようにして、減衰率設定部４７で設定した減衰率Kdec を用いて中間目標値計算部４６で中間目標値O2midtarg(i) を計算した後、この中間目標値O2midtarg(i) を用いて次式により上流側目標空燃比ＡＦref の補正量ＡＦcomp(i)を算出する。

$$AFcomp(i) = Fsat\ \{K1 \times (O2midtarg(i) - O2out(i)) + K2 \times \Sigma\ (O2midtarg(i) - O2out(i))\}$$
$$= Fsat\ (K1 \times \Delta O2(i) + K2 \times \Sigma \Delta O2(i))$$

但し、$\Delta O2(i) = O2midtarg(i) - O2out(i)$

【００３０】上式において、Fsat は図５に示すような特性の飽和関数であり、補正量ＡＦcomp(i) は、K1 ×ΔO2(i)＋K2 ×Σ（ΔO2(i)）の演算値を上限ガード値と下限ガード値でガード処理して求められる。上式において、K1 は比例ゲイン、K2 は積分ゲインである。K1 ×ΔO2(i)は比例項であり、中間目標値O2midtarg(i) と下流側排ガスセンサ２５の出力O2out(i) との偏差ΔO2(i)が大きくなるほど、大きくなる。また、K2 ×ΣΔO2(i)は積分項であり、中間目標値O2midtarg(i) と下流側排ガスセンサ２５の出力O2out(i) との偏差ΔO2(i)の積算値が大きくなるほど、大きくなる。補正量ＡＦcomp(i) は、比例項と積分項を加算して求めた値を上限ガード値と下限ガード値でガード処理して求められる。

【００３１】以上説明した目標空燃比補正部４４による補正量ＡＦcomp(i) の算出は、図６の補正量算出プログラムに従って行われる。本プログラムは、所定時間毎又は所定クランク角毎に実行される。本プログラムが起動されると、まずステップ１０１で、現在の下流側排ガスセンサ２５の出力O2out(i) を読み込み、次のステップ１０２で、排ガス流量又は触媒反応速度に関連するパラメータを読み込む。

【００３２】ここで、排ガス流量に関連するパラメータとしては、吸入空気量、エンジン回転速度、吸気管圧力、スロットル開度等の中からいずれか１つ又は複数のパラメータを用いれば良く、勿論、これらのパラメータから排ガス流量を算出するようしても良い。また、触媒反応速度に関連するパラメータとしては、触媒温度（排気温度や始動後経過時間等で代替可能）、触媒２３の劣化度合、触媒２３のO_2ストレージ量（リーン／リッチ成分吸着量）等の中からいずれか１つ又は複数のパラメータを用いれば良く、勿論、これらのパラメータから触媒反応速度を算出するようにしても良い。

【００３３】この後、ステップ１０３で、排ガス流量又は触媒反応速度に関連するパラメータに応じて図４のマップ又は数式によって減衰率Kdec を設定する。そして、次のステップ１０４で、この減衰率Kdec を用いて、前回演算時の下流側排ガスセンサ２５の出力O2out(i-1) と最終目標値O2targ(i)（最終的な下流側目標空燃比）とに基づいて中間目標値O2midtarg(i) を前記（１）式を用いて算出する。これにより、前回演算時の下流側排ガスセンサ２５の出力O2out(i-1) と最終目標値O2targ(i)との間に中間目標値O2midtarg(i) が設定される。

【００３４】この後、ステップ１０５に進み、中間目標値O2midtarg(i) と下流側排ガスセンサ２５の出力O2out(i) との偏差ΔO2(i)を算出する。

$$\Delta O2(i) = O2midtarg(i) - O2out(i)$$

そして、次のステップ１０６で、前回までの偏差ΔO2の積算値ΣΔO2(i-1)に今回の偏差ΔO2(i)を積算して、今回までの偏差ΔO2 の積算値ΣΔO2(i)を求める。

$$\Sigma \Delta O2(i) = \Sigma \Delta O2(i-1) + \Delta O2(i)$$

【００３５】この後、ステップ１０７に進み、上流側目標空燃比ＡＦref の補正量ＡＦcomp(i) を次式により算出する。

$$AFcomp(i) = Fsat\ (K1 \times \Delta O2(i) + K2 \times \Sigma \Delta O2(i))$$

これにより、上流側目標空燃比ＡＦref の補正量ＡＦcomp(i) は比例項（K1×ΔO2(i)）と積分項（K2 ×Σ

比センサ（リニアＡ／Ｆセンサ）に代えて、酸素センサを用いても良い。

【００４８】また、前記各実施形態では、中間目標値Ｏ2midtarg(i) を算出する際に前回演算時の下流側排ガスセンサ２５の出力Ｏ2out(i-1) を用いたが、所定演算回数前の下流側排ガスセンサ２５の出力Ｏ2out(i-n) を用いても良い。

【００４９】その他、本発明は、中間目標値Ｏ2midtarg(i) の算出式や補正量ＡＦcomp(i)の算出式を適宜変更しても良い等、種々変更して実施できることは言うまでもない。

【図面の簡単な説明】

【図１】本発明の実施形態（１）を示すエンジン制御システム全体の概略構成図

【図２】ＥＣＵのＣＰＵの演算処理機能で実現する空燃比制御手段の機能を示すブロック図

【図３】空燃比フィードバック制御システム全体の機能を示す機能ブロック図

【図４】排ガス流量（又は触媒反応速度）に応じて減衰率Ｋdec を設定するマップを概念的に示す図

【図５】補正量ＡＦcomp(i) を算出する飽和関数を説明する図

【図６】実施形態（１）の補正量算出プログラムの処理の流れを示すフローチャート

【図７】排ガス流量（又は触媒反応速度）に応じて比例ゲインＫ1 （積分ゲインＫ2 ）を設定するマップを概念的に示す図

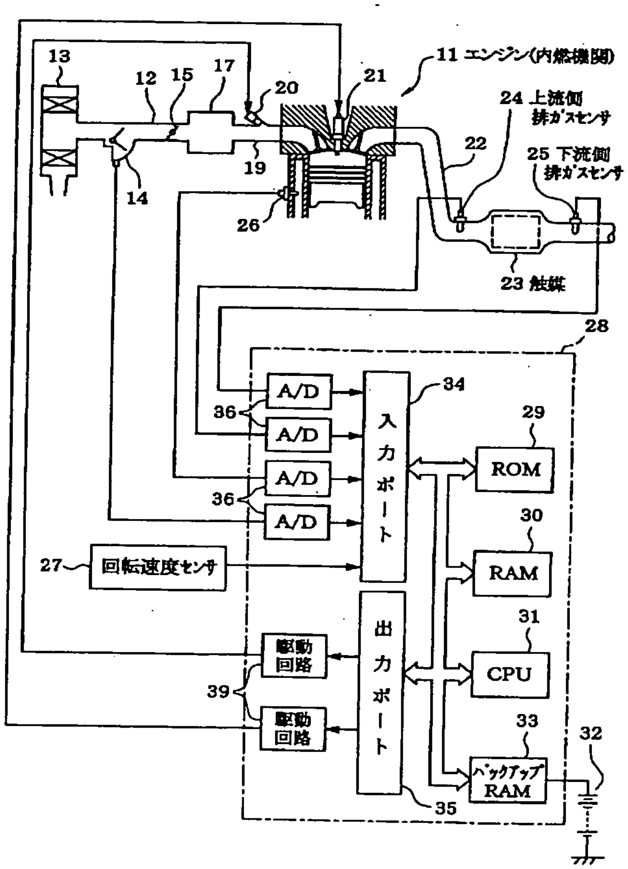
【図８】排ガス流量（又は触媒反応速度）に応じて制御範囲を設定するマップを概念的に示す図

【図９】実施形態（２）の補正量算出プログラムの処理の流れを示すフローチャート

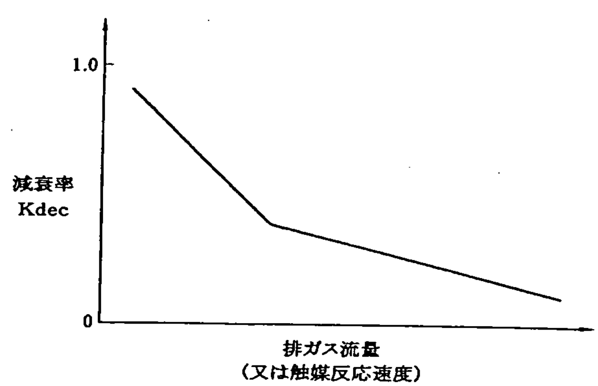
【符号の説明】

１１…エンジン（内燃機関）、２０…燃料噴射弁、２２…排気管、２３…触媒、２４…上流側排ガスセンサ、２５…下流側排ガスセンサ、２８…ＥＣＵ（空燃比フィードバック制御手段，サブフィードバック制御手段，中間目標値設定手段）、３１…ＣＰＵ、４０…空燃比制御手段、４１…燃料噴射量フィードバック制御部（空燃比フィードバック制御手段）、４２…目標空燃比計算部（サブフィードバック制御手段）、４３…負荷目標空燃比計算部、４４…目標空燃比補正部、４５…時間遅れ要素（１／ｚ）、４６…中間目標値計算部（中間目標値設定手段）、４７…減衰率設定部（制御補正手段）、４７…補正量計算部。

【図１】



【図４】



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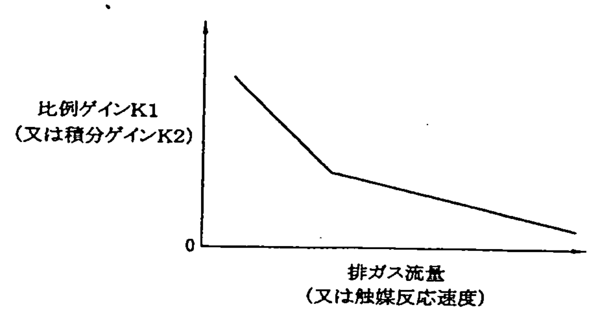

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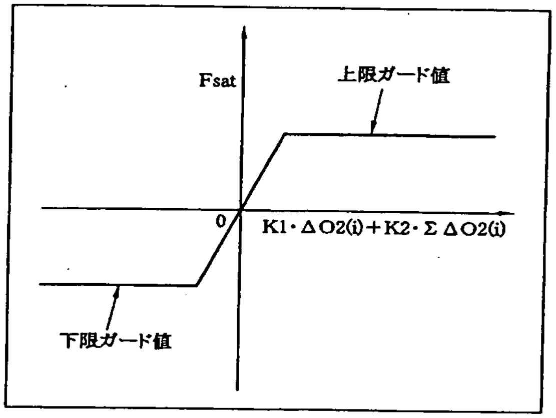

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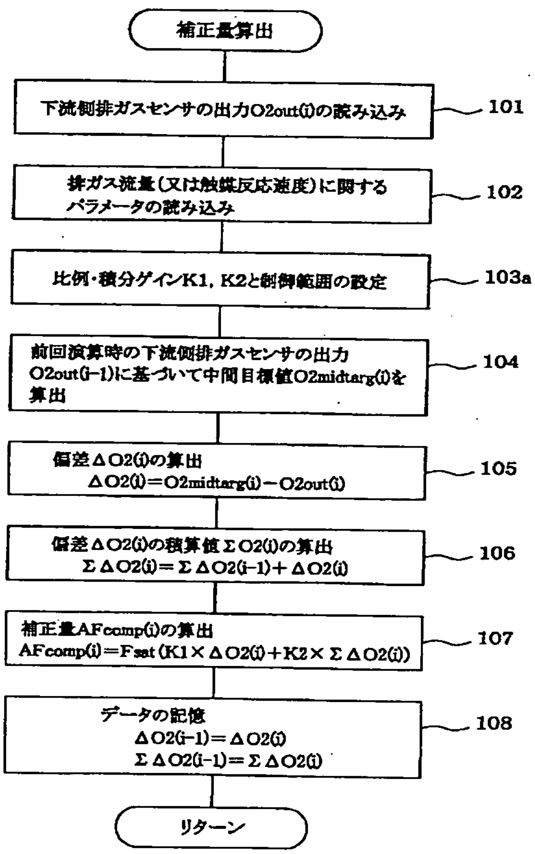

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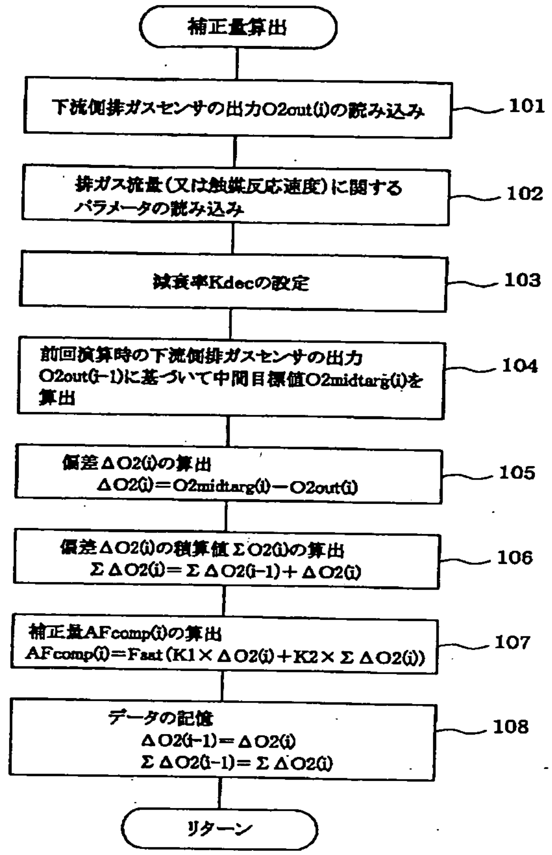

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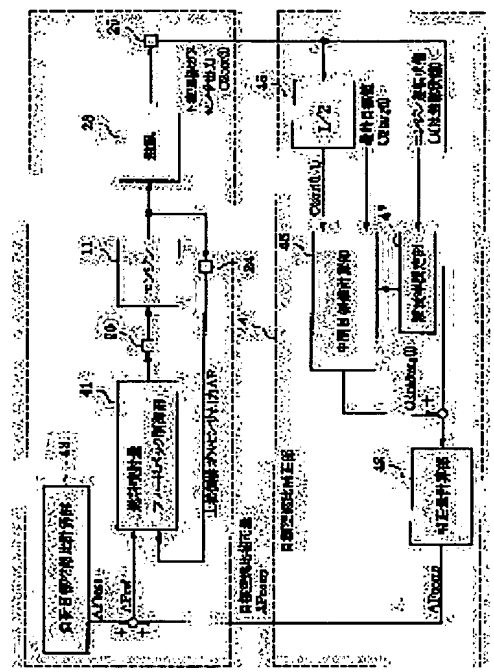
(54) AIR FUEL RATIO CONTROLLER FOR INTERNAL COMBUSTION ENGINE

(57)Abstract:

PROBLEM TO BE SOLVED: To execute a sub-feedback control for making response and stability compatible by correctly changing the control to a proper control condition corresponding to the operating state of an internal combustion engine or the change of the catalyst condition in a system executing a main/sub-feedback control using an intermediate target value.

SOLUTION: Exhaust gas sensors 24, 25 are provided on an upstream side and a downstream side of the catalyst 23 respectively to set the intermediate target value based on the output of the exhaust gas sensor 25 on the downstream side at the last calculation time and the final target value (final downstream side target air fuel ratio). The correction amount for the upstream side target air fuel ratio is calculated based on the deviation between the output of the current downstream side exhaust gas sensor 25 and the intermediate target value. In this case at least one of the updated amount of the intermediate target value, an updated speed, a control gain of the sub-feedback control, a control cycle and a control range is changed corresponding to a parameter related to the exhaust gas flow amount or catalyst reaction speed, thus executing the highly responsive sub-feedback control faithfully following the change of the operational condition and the change of the catalyst 23 condition.



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CLAIMS

[Claim(s)]
[Claim 1] The upstream exhaust gas sensor and downstream exhaust gas sensor which detect the air-fuel ratio of exhaust gas, or rich/Lean by the upstream and the downstream of a catalyst for emission gas purification, respectively, The feed-back-control-of-air-fuel-ratio means which carries out feedback control of the fuel oil consumption so that the detection air-fuel ratio of said upstream exhaust gas sensor may turn into an upstream target air-fuel ratio, An intermediate objective value setting-out means to set up an intermediate objective value based on the detection air-fuel ratio of the past of said downstream exhaust gas sensor, and a final downstream target air-fuel ratio, In the air-fuel ratio control system of the internal combustion engine having a sub feedback control means to perform sub feedback control which amends said upstream target air-fuel ratio based on the detection air-fuel ratio and said intermediate objective value of said downstream exhaust gas sensor It responds to the parameter relevant to an internal combustion engine's operational status or the condition of said catalyst. The air-fuel ratio control system of the internal combustion engine characterized by having the amount of updating of said intermediate objective value, an update rate, the control gain of said sub feedback control, the control period, and a control amendment means to change at least one of control ranges.
[Claim 2] Said control amendment means is the air-fuel ratio control system of the internal combustion engine according to claim 1 characterized by changing at least one of the amount of updating of said intermediate objective value, an update rate, the control gain of said sub feedback control, a control period, and control ranges according to the parameter relevant to the amount of emission, or a catalytic-reaction rate.
[Claim 3] Said intermediate objective value setting-out means is the air-fuel ratio control system of the internal combustion engine according to claim 1 or 2 which adds the value which carried out the multiplication of the attenuation factor to the deflection of the detection air-fuel ratio of the past of said downstream exhaust gas sensor, and a final downstream target air-fuel ratio, and a final downstream target air-fuel ratio, calculates said intermediate objective value, and is characterized by said control amendment means changing said attenuation factor according to the parameter relevant to said internal combustion engine's operational status, or the condition of said catalyst.
[Claim 4] The amount of amendments of said upstream target air-fuel ratio is calculated with said sub feedback control means restricting the value calculated by the proportional plus integral action to the deflection of the detection air-fuel ratio of said downstream exhaust gas sensor, and said intermediate objective value in a predetermined control range. Said control amendment means is the air-fuel ratio control system of the internal combustion engine according to claim 1 to 3 characterized by changing the gain and/or said control range of said proportional plus integral action according to the parameter relevant to said internal combustion engine's operational status, or the condition of said catalyst.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the air-fuel ratio control system of the internal combustion engine which installs an air-fuel ratio sensor (linear A/F sensor) or an oxygen sensor in the upstream and the downstream of a catalyst for emission gas purification, respectively, and does feedback control of an internal combustion engine's air-fuel ratio.
[0002]
[Description of the Prior Art] Although today's automobile installs a three way component catalyst in an exhaust pipe and he is trying to purify exhaust gas, in order to raise the rate of emission gas purification of a catalyst, it needs to control the air-fuel ratio of exhaust gas in the clarification window of a catalyst (near theoretical air fuel ratio). Then, an exhaust gas sensor (an air-fuel ratio sensor or oxygen sensor) is installed in the upstream and the downstream of a catalyst, respectively, and while carrying out feedback control of the fuel oil consumption so that the air-fuel ratio of the exhaust gas detected by the upstream exhaust gas sensor may turn into an upstream target air-fuel ratio, there are some which were made to carry out sub feedback control which amends an upstream target air-fuel ratio so that the air-fuel ratio of the exhaust gas detected by the downstream exhaust gas sensor may turn into a downstream target air-fuel ratio.
[0003] In such Maine / a subfeedback system, enlarging the amount of updating of a feed-back-control-of-air-fuel-ratio constant (for example, the amount of skips) is proposed, so that the deflection of the detection air-fuel ratio of a downstream exhaust gas sensor and a downstream target air-fuel ratio becomes large, as shown in the patent No. 2518247 official report.
[0004]
[Problem(s) to be Solved by the Invention] By the way, it cannot be said that it is enough as the responsibility of the sub feedback control to change of the dynamic characteristics of a catalyst although the dynamic characteristics of a catalyst changes with the degradation degree of a catalyst, Lean / rich component adsorbed state within a catalyst, and engine operation conditions. [of the above-mentioned conventional Maine / subfeedback system] For this reason, the response delay of sub feedback control occurs to change of the dynamic characteristics of a catalyst, the air-fuel ratio (output of a downstream exhaust gas sensor) of the catalyst downstream may become unstable, and hunting may occur.
[0005] Then, in order to cancel this fault, this invention persons set up the intermediate objective value of sub feedback control based on the detection air-fuel ratio of the past of a downstream exhaust gas sensor, and a final downstream target air-fuel ratio, turn to utilization the system which performs sub feedback control which amends an upstream target air-fuel ratio based on the deflection of the detection air-fuel ratio of a downstream exhaust gas sensor, and said intermediate objective value, and are developing it as indicated by the description of an application for patent No. 404671 [2000 to].
[0006] In making this system utilization, the following new technical technical problems have become clear. That is, the catalyst has a big delay system (the dead time and time constant), and it changes with the amount of emission, or catalytic-reaction rates a lot. In that case, if it suits on late conditions in order to prevent hunting, the renewal of an intermediate objective value (responsibility of sub feedback control) used for sub feedback control Although renewal of an intermediate objective value becomes moderate when there are few amounts of emission, or when a catalytic-reaction rate is slow (when the clarification engine performance of a catalyst is falling) When there are many amounts of emission, or when a catalytic-reaction rate is quick, the renewal of

medium desired value (responsibility of sub feedback control) becomes slow too much, and cannot secure sufficient emission-gas-purification engine performance.

[0007] This invention is made in consideration of such a situation. Therefore, the object In the system which performs Maine / sub feedback control using an intermediate objective value Sub feedback control who reconciled responsibility and stability while changing into a proper control condition according to change of an internal combustion engine's operational status or the condition of a catalyst can be performed. It is in offering the air-fuel ratio control system of the internal combustion engine which can secure the stable emission-gas-purification engine performance influenced by neither an internal combustion engine's operational status nor the condition of a catalyst.

[0008]

[Means for Solving the Problem] In order to attain the above-mentioned object, the air-fuel ratio control system of the internal combustion engine of claim 1 of this invention Based on the detection air-fuel ratio of the past of a downstream exhaust gas sensor, and a final downstream target air-fuel ratio, the intermediate objective value of sub feedback control is set up. In what performs sub feedback control which amends an upstream target air-fuel ratio based on the deflection of the detection air-fuel ratio of a downstream exhaust gas sensor, and said intermediate objective value According to the parameter relevant to an internal combustion engine's operational status or the condition of said catalyst, at least one of the amount of updating of said intermediate objective value, an update rate, the control gain of said sub feedback control, a control period, and control ranges is changed with a control amendment means. If it does in this way, sub feedback control who reconciled responsibility and stability can be performed changing into a proper control condition according to change of an internal combustion engine's operational status or the condition of a catalyst, and the stable emission-gas-purification engine performance influenced by neither an internal combustion engine's operational status nor the condition of a catalyst can be secured.

[0009] As a parameter relevant to an internal combustion engine's operational status here For example, the amount of emission, an inhalation air content, an engine speed, pressure-of-induction-pipe force, A throttle opening, the vehicle speed, cooling water temperature, an exhaust-gas temperature, an idle switch signal, As a parameter relevant to the condition of a catalyst, that what is necessary is just to use any one or two or more parameters out of the elapsed time after start up etc. It is O2 of a catalyst de-activation degree and a catalyst whenever [catalytic-reaction rate and catalyst temperature] (the alternative with an exhaust-gas temperature, the elapsed time after start up, etc. is possible). What is necessary is just to use any one or two or more parameters out of the amount of storage (Lean / rich component amount of adsorption) etc.

[0010] In this case, it is good to change at least one of the amount of updating of said intermediate objective value, an update rate, the control gain of said sub feedback control, a control period, and control ranges like claim 2 according to the parameter relevant to the amount of emission, or a catalytic-reaction rate in consideration of the delay system (the dead time and time constant) by the catalyst changing with the amount of emission, or catalytic-reaction rates a lot. If it does in this way, it is stabilized in change of the delay system (the dead time and time constant) by the catalyst, and sub feedback control of the high response followed with the sufficient response can be carried out to it.

[0011] Moreover, the value which carried out the multiplication of the attenuation factor to the deflection of the detection air-fuel ratio of the past of a downstream exhaust gas sensor and a final downstream target air-fuel ratio, and a final downstream target air-fuel ratio are added like claim 3, an intermediate objective value is calculated, and you may make it change an attenuation factor according to the parameter relevant to an internal combustion engine's operational status or the condition of a catalyst. If it does in this way, while being able to set up medium desired value by easy data processing, the control condition which followed change of an internal combustion engine's operational status or the condition of a catalyst can be changed by easy data processing.

[0012] Moreover, the amount of amendments of an upstream target air-fuel ratio is calculated, and you may make it change the gain (control gain) and/or the control range of a parameter ****** proportional plus integral action relevant to an internal combustion engine's operational status or the condition of a catalyst with restricting the value calculated by the proportional plus integral action to the deflection of the detection air-fuel ratio of a downstream exhaust gas sensor, and an intermediate objective value in a predetermined control range like claim 4. If it does in this way, while being able to make change of the dynamic characteristics of a catalyst

reflect in the amount of amendments of an upstream target air-fuel ratio with a sufficient response, the control condition which followed change of an internal combustion engine's operational status or the condition of a catalyst can be changed by easy data processing.
[0013]
[Embodiment of the Invention] The operation gestalt (1) of this invention is explained based on drawing 1 thru/or drawing 6 below [an operation gestalt (1)]. First, based on drawing 1 , the outline configuration of the whole engine control system is explained. An air cleaner 13 is formed in the maximum upstream section of the inlet pipe 12 of the engine 11 which is an internal combustion engine, and the air flow meter 14 which detects an inhalation air content is formed in the downstream of this air cleaner 13 at it. The throttle valve 15 is formed in the downstream of this air flow meter 14.
[0014] Furthermore, a surge tank 17 is formed in the downstream of a throttle valve 15, and the inlet manifold 19 which introduces air into this surge tank 17 at each cylinder of an engine 11 is formed. Near the inlet port of the inlet manifold 19 of each cylinder, the fuel injection valve 20 which injects a fuel, respectively is attached. Moreover, the ignition plug 21 is attached in the cylinder head of an engine 11 for every cylinder.
[0015] On the other hand, in the middle of the exhaust pipe 22 of an engine 11, the catalysts 23, such as a three way component catalyst which purifies CO, HC, NOx, etc. in exhaust gas, are installed. The exhaust gas sensors 24 and 25 which detect an exhaust gas air-fuel ratio, or rich/Lean, respectively are installed in the upstream and the downstream of this catalyst 23. or [that the air-fuel ratio sensor (linear A/F sensor) by which the upstream exhaust gas sensor 24 outputs the linear air-fuel ratio signal according to an exhaust gas air-fuel ratio is used with this operation gestalt, and the downstream exhaust gas sensor 25 has the rich air-fuel ratio of exhaust gas to theoretical air fuel ratio] -- the oxygen sensor which output voltage reverses depending on whether you are Lean is used. Therefore, the downstream exhaust gas sensor 25 generates about [0.1V] output voltage, when an air-fuel ratio is Lean, and when an air-fuel ratio is rich, it generates about [0.9V] output voltage. In addition, the coolant temperature sensor 26 which detects cooling water temperature, and the rotational-speed sensor 27 which detects an engine speed are attached in the cylinder block of an engine 11.
[0016] The engine control circuit (it is written as "ECU" below) 28 is constituted considering the microcomputer which consists of the backup RAM 33 backed up with ROM29, RAM30, CPU31, and a dc-battery 32, input port 34, and output port 35 grade as a subject. While the output signal of the rotational-speed sensor 27 is inputted, the output signal of an air flow meter 14, the upstream and the downstream exhaust gas sensors 24 and 25, and a coolant temperature sensor 26 is inputted into input port 34 through A/D converter 36, respectively. Moreover, the fuel injection valve 20 and the ignition plug 21 grade are connected to the output port 35 through the actuation circuit 39.
[0017] ECU28 carries out feedback control of the air-fuel ratio (fuel oil consumption) by performing the Air Fuel Ratio Control program so that the air-fuel ratio of exhaust gas may turn into a target air-fuel ratio, while controlling actuation of a fuel injection valve 20 or an ignition plug 21 by performing the fuel-injection control program memorized by ROM29 and an ignition control program by CPU31.
[0018] Hereafter, the feed-back-control-of-air-fuel-ratio system of this operation gestalt (1) is explained based on drawing 2 and drawing 3 . The block diagram showing the function of an Air Fuel Ratio Control means 40 to realize drawing 2 by the data-processing function of CPU31 here, and drawing 3 R> 3 are the block diagrams showing the function of the whole feed-back-control-of-air-fuel-ratio system.
[0019] The Air Fuel Ratio Control means 40 consists of the fuel-oil-consumption feedback control section 41 and the target air-fuel ratio count section 42, and the target air-fuel ratio count section 42 consists of the load target air-fuel ratio count section 43 and the target air-fuel ratio amendment section 44.
[0020] For the fuel-oil-consumption feedback control section 41, the detection air-fuel ratio AF of the upstream exhaust gas sensor 24 is the upstream target air-fuel ratio AFref. It is the fuel injection duration Tinj of a fuel injection valve 20 so that it may converge. It computes. This fuel injection duration Tinj Calculation is performed by the optimal regulator built to the linear equation of the model of a controlled system. This fuel-oil-consumption feedback control section 41 plays the role equivalent to the feed-back-control-of-air-fuel-ratio means as used in the field of a claim.
[0021] On the other hand, the load target air-fuel ratio count section 43 computes the load target air-fuel ratio AFbase according to an inhalation air content (or pressure-of-induction-pipe force) and an engine speed on the function expression or map memorized by ROM29. The function expression or map for computing this load

target air-fuel ratio AFbase Output O2out (detection air-fuel ratio) of the downstream exhaust gas sensor 25 when equal to policy objective value O2targ (final downstream target air-fuel ratio) steady almost Upstream target air-fuel ratio AFref If it maintains to the load target air-fuel ratio AFbase, output O2out of the downstream exhaust gas sensor 25 will be policy objective value O2targ. It is beforehand set up by trial etc. so that it may be maintained near.

[0022] Moreover, based on output O2out of the downstream exhaust gas sensor 25, intermediate objective value O2midtarg mentioned later is used for the target air-fuel ratio amendment section 44, and it is the upstream target air-fuel ratio AFref. The amount AFcomp of amendments is computed. And it is the upstream target air-fuel ratio AFref by adding this amount AFcomp of amendments to the load target air-fuel ratio AFbase. It asks and is this upstream target air-fuel ratio AFref. It inputs into the fuel-oil-consumption feedback control section 41.

It replaces with AFref =AFbase+AFcomp, in addition a top type, and is the upstream target air-fuel ratio AFref by the degree type. You may compute.

AFref =(1+AFcomp) xAFbase [0023] In this case, the target air-fuel ratio count section 42 (the load target air-fuel ratio count section 43 and target air-fuel ratio amendment section 44) plays the role equivalent to the sub feedback control means as used in the field of a claim.

[0024] Next, medium desired value O2midtarg is set up in the target air-fuel ratio amendment section 44, and it is the upstream target air-fuel ratio AFref. How to compute the amount AFcomp of amendments is explained based on drawing 3 . Let a controlled system be the system which consists of the fuel-oil-consumption feedback control section 41, a fuel injection valve 20, an engine 11, a catalyst 23, and downstream exhaust gas sensor 25 grade. For the target air-fuel ratio amendment section 44, it consists of the time lag element (1/z) 45, the intermediate objective value count section 46, the attenuation factor setting-out section 47, and the amount count section 48 of amendments, and the time lag element 45 is output O2out (i-1) of the downstream exhaust gas sensor 25 at the time of an operation last time. It inputs into the intermediate objective value count section 46.

[0025] On the other hand, the intermediate objective value count section 46 plays the role equivalent to the intermediate objective value setting-out means as used in the field of a claim, and is output O2out (i-1) of the downstream exhaust gas sensor 25 at the time of an operation last time. It is based on policy objective value O2targ (i) (final downstream target air-fuel ratio), and is intermediate objective value O2midtarg (i). It calculates using the following (1) type. Thereby, it is output O2out (i-1) of the downstream exhaust gas sensor 25 at the time of an operation last time. It is intermediate objective value O2midtarg (i) between policy objective value O2targ(s) (i). It is set up.

O2midtarg (i) =O2targ(i)+Kdec x {O2out (i-1)-O2targ (i)}
.... (1)

[0026] Setting at a top ceremony, O2targ (i) is this policy objective value and O2out (i-1). It is the output of the downstream exhaust gas sensor 25 at the time of an operation last time. Moreover, Kdec It is a damping factor, is the damping-factor setting-out section 47, and is set up within the limits of $0<Kdec<1$ according to the parameter relevant to an engine operation condition or the condition of a catalyst 23. As a parameter relevant to an engine operation condition here For example, the amount of emission, an inhalation air content, an engine speed, pressure-of-induction-pipe force, A throttle opening, the vehicle speed, cooling water temperature, an exhaust-gas temperature, an idle switch signal, As a parameter parameter relevant to the condition of a catalyst 23, that what is necessary is just to use any one or two or more parameters out of the elapsed time after start up etc. They are the degradation degree of a catalyst 23, and 23 catalystO2 whenever [catalytic-reaction rate and catalyst temperature] (the alternative with an exhaust-gas temperature, the elapsed time after start up, etc. is possible). What is necessary is just to use any one or two or more parameters out of the amount of storage (Lean / rich component amount of adsorption) etc.

[0027] In consideration of the delay system (the dead time and time constant) by the catalyst 23 changing with the amount of emission, or catalytic-reaction rates a lot with this operation gestalt (1), the attenuation factor setting-out section 47 responds to the parameter relevant to the amount of emission, or a catalytic-reaction rate, and is an attenuation factor Kdec by the map or formula of drawing 4 . It sets up. Here, of course as a parameter relevant to the amount of emission, you may carry out [that what is necessary is just to use any one or two or more parameters out of an inhalation air content, an engine speed, the pressure-of-induction-pipe force, a

throttle opening, etc.] as [compute / from these parameters / the amount of emission]. Moreover, as a parameter relevant to a catalytic-reaction rate, they are the degradation degree of a catalyst 23, and 23 catalystO2 whenever [catalyst temperature] (the alternative with an exhaust-gas temperature, the elapsed time after start up, etc. is possible). You may make it compute a catalytic-reaction rate from these parameters, of course that what is necessary is just to use any one or two or more parameters out of the amount of storage (Lean / rich component amount of adsorption) etc.

[0028] The amount of emission the property of the attenuation factor setting-out map of drawing 4 few (a catalytic-reaction rate is) indeed Attenuation factor Kdec It becomes large and is intermediate objective value O2midtarg (i). In order that the amount of updating may become large and the amount of emission may prevent many (a catalytic-reaction rate is) hunting indeed Attenuation factor Kdec It becomes small and is intermediate objective value O2midtarg (i). It is set up so that the amount of updating may become small. In addition, the attenuation factor setting-out section 47 plays the role equivalent to the control amendment means as used in the field of a claim.

[0029] Attenuation factor Kdec set up in the attenuation factor setting-out section 47 as mentioned above It uses and is intermediate objective value O2midtarg (i) at the intermediate objective value count section 46. This intermediate objective value O2midtarg after calculating (i) It uses and is the upstream target air-fuel ratio AFref by the degree type. The amount AFcomp of amendments (i) is computed.

AFcomp (i) =Fsat {K1 x(O2midtarg (i)-O2out(i))+K2 xsigma (O2midtarg (i)-O2out(i))}
= Fsat (K1 xdeltaO2(i)+K2 xsigmadeltaO2 (i))

However, deltaO2(i) =O2midtarg (i) -O2out(i) [0030] It sets at a top ceremony and is Fsat. It is the saturation function of a property as shown in drawing 5 , and is the amount AFcomp of amendments (i). Guard processing of the operation value of K1 xdeltaO2(i)+K2 xsigma (deltaO2 (i)) is carried out with an upper limit guard value and a minimum guard value, and it asks. It sets at a top ceremony and is K1. Proportional gain and K2 It is integral gain. K1 xdeltaO2(i) is a proportional and is intermediate objective value O2midtarg (i). Output O2out (i) of the downstream exhaust gas sensor 25 It becomes large, so that deflection deltaO2 (i) becomes large. Moreover, K2 xsigmadeltaO2 (i) is an integral term, and is intermediate objective value O2midtarg (i). Output O2out(i) of the downstream exhaust gas sensor 25 It becomes large, so that the integrated value of deflection deltaO2 (i) becomes large. The amount AFcomp of amendments (i) Guard processing of the value which added and searched for the proportional and the integral term is carried out with an upper limit guard value and a minimum guard value, and it asks.

[0031] The amount AFcomp of amendments by the target air-fuel ratio amendment section 44 explained above (i) Calculation is performed according to the amount calculation program of amendments of drawing 6 . This program is performed for every predetermined time and every predetermined crank angle. When this program is started, it is output O2out(i) of the current downstream exhaust gas sensor 25 at step 101 first. It reads and the parameter relevant to the amount of emission or a catalytic-reaction rate is read at the following step 102.

[0032] Here, of course as a parameter relevant to the amount of emission, you may carry out [that what is necessary is just to use any one or two or more parameters out of an inhalation air content, an engine speed, the pressure-of-induction-pipe force, a throttle opening, etc.] as [compute / from these parameters / the amount of emission]. Moreover, you may make it compute [whenever / catalyst temperature / (the alternative with an exhaust-gas temperature, the elapsed time after start up, etc. is possible)] a catalytic-reaction rate from these parameters, of course as a parameter relevant to a catalytic-reaction rate that what is necessary is just to use any one or two or more parameters out of the degradation degree of a catalyst 23, the amount of O2 storage of a catalyst 23 (Lean / rich component amount of adsorption), etc.

[0033] Then, it responds to the parameter relevant to the amount of emission, or a catalytic-reaction rate at step 103, and is an attenuation factor Kdec by the map or formula of drawing 4 . It sets up. And it is this attenuation factor Kdec at the following step 104. It uses and is output O2out (i-1) of the downstream exhaust gas sensor 25 at the time of an operation last time. It is based on policy objective value O2targ (i) (final downstream target air-fuel ratio), and is intermediate objective value O2midtarg (i). It computes using the aforementioned (1) formula. Thereby, it is output O2out (i-1) of the downstream exhaust gas sensor 25 at the time of an operation last time. It is intermediate objective value O2midtarg (i) between policy objective value O2targ(s) (i). It is set up.

[0034] Then, it progresses to step 105 and is intermediate objective value O2midtarg (i). Output O2out(i) of the

downstream exhaust gas sensor 25 Deflection deltaO2 (i) is computed.
deltaO2(i) =O2midtarg (i) It is the deflection deltaO2 to last time at -O2out(i) and step 106 of a degree. This deflection deltaO2 (i) is integrated to an integrated value sigmadeltaO2 (i-1), and it is the deflection deltaO2 by this time. An integrated value sigmadeltaO2 (i) is calculated.
sigmadeltaO2(i) =sigmadeltaO2(i-1)+deltaO2(i) [0035] Then, it progresses to step 107 and is the upstream target air-fuel ratio AFref. The amount AFcomp of amendments (i) It computes by the degree type.
AFcomp (i) =Fsat (K1 xdeltaO2(i)+K2 xsigmadeltaO2 (i))
Thereby, it is the upstream target air-fuel ratio AFref. The amount AFcomp of amendments (i) Guard processing of the value which added and searched for the proportional (K1xdeltaO2(i)) and the integral term (K2 xsigmadeltaO2 (i)) is carried out with an upper limit guard value and a minimum guard value, and it asks. And at the following step 108, this deltaO2 (i) and sigmadeltaO2 (i) are memorized as delta O2 [last] (i-1) and sigmadeltaO2 [last] (i-1), respectively, and this program is ended.
[0036] During engine operation, it is the upstream target air-fuel ratio AFref by adding the amount AFcomp of amendments which computed the load target air-fuel ratio AFbase according to an inhalation air content (or pressure-of-induction-pipe force) and an engine speed, and was computed by the amount calculation program of amendments of above-mentioned drawing 6 to the load target air-fuel ratio AFbase. It asks and the detection air-fuel ratio AF of the upstream exhaust gas sensor 24 is the upstream target air-fuel ratio AFref. Fuel injection duration Tinj (fuel oil consumption) is computed so that it may converge.
[0037] According to this operation gestalt (1) explained above, it takes into consideration that the delay system (the dead time and time constant) by the catalyst 23 changes with the amount of emission, or catalytic-reaction rates a lot. It responds to the parameter relevant to the amount of emission, or a catalytic-reaction rate, and is an attenuation factor Kdec. It changes and is intermediate objective value O2midtarg (i). Since the amount of updating was changed It can be stabilized, sub feedback control of the high response followed with the sufficient response to change of the delay system (the dead time and time constant) by the catalyst 23 can be performed, and the stable emission-gas-purification engine performance influenced by neither an engine operation condition nor the condition of a catalyst 23 can be secured.
[0038] In addition, at this operation gestalt (1), it is an attenuation factor Kdec. By changing, it is intermediate objective value O2midtarg (i). Although the amount of updating was changed, it is intermediate objective value O2midtarg (i) with approaches other than this. You may make it change the amount of updating. Or it responds to the parameter relevant to the amount of emission, or a catalytic-reaction rate, and is intermediate objective value O2midtarg (i). You may make it change an updating period (update rate).
[0039] With the [operation gestalt (2)] above-mentioned implementation gestalt (1), it responds to the parameter relevant to the amount of emission, or a catalytic-reaction rate, and is an attenuation factor Kdec. Although it was made to make sub feedback control follow change of the delay system (the dead time and time constant) by the catalyst 23 with a sufficient response by changing With the operation gestalt (2) of this invention shown in drawing 7 thru/or drawing 9 According to the parameter relevant to the amount of emission, or a catalytic-reaction rate, as shown in drawing 7 and drawing 8 , it is proportion / integral gain K1 and K2. By changing a control range (an upper limit guard value and minimum guard value) He is trying to make sub feedback control follow change of the delay system (the dead time and time constant) by the catalyst 23 with a sufficient response.
[0040] The property of a map of changing the proportional gain K1 (integral gain K2) of drawing 7 Proportional gain K1 (integral gain K2) becomes [the amount of emission] few (a catalytic-reaction rate is) greatly indeed. It is set up so that a control rate becomes quick, proportional gain K1 (integral gain K2) may become small in order that the amount of emission may prevent many (a catalytic-reaction rate is) hunting indeed, and a control rate may become slow.
[0041] Moreover, there are few amounts of emission (a catalytic-reaction rate is), and a control range becomes narrow, there are many amounts of emission (a catalytic-reaction rate is), and indeed, the property of a map of changing the control range (an upper limit guard value and minimum guard value) of drawing 8 is set up so that a control range may become large.
[0042] The amount calculation program of amendments of drawing 9 used with this operation gestalt (2) changes into processing of step 103a processing of step 103 of the amount calculation program of amendments of drawing 6 explained with said operation gestalt (1), and processing of each other step is the same. In the

amount calculation program of amendments of drawing 9 , after reading the parameter relevant to the amount of emission, or a catalytic-reaction rate at step 102, it progresses to step 103a and responds to the parameter relevant to the amount of emission, or a catalytic-reaction rate, and it is proportion / integral gain K1 and K2 by the map of drawing 7 and drawing 8 . A control range (an upper limit guard value and minimum guard value) is changed. And it is based on output O2out (i-1) and policy objective value O2targ (i) of the downstream exhaust gas sensor 25 at the time of an operation last time, and is intermediate objective value O2midtarg (i). After computing, Proportion / integral gain K1 set up by the above-mentioned step 103a, and K2 A control range (an upper limit guard value and minimum guard value) is used, and it is the upstream target air-fuel ratio AFref. The amount AFcomp of amendments (i) It computes (steps 105-107).

[0043] In addition, at this operation gestalt (2), it is an attenuation factor Kdec. Because of simplification of data processing, it is good also as a fixed value. Moreover, intermediate objective value O2midtarg (i) It is output O2out (i-1) of the downstream exhaust gas sensor 25 at the time of an operation last time. You may make it compute on the 2-dimensional map which makes a parameter policy objective value O2targ (i).

[0044] Like this operation gestalt (2) explained above, it responds to the parameter relevant to the amount of emission, or a catalytic-reaction rate, and is proportion / integral gain K1 and K2. Even if it changes a control range (an upper limit guard value and minimum guard value) It is stabilized and sub feedback control of the high response followed with the sufficient response to change of the delay system (the dead time and time constant) by the catalyst 23 like said operation gestalt (1) can be performed. The stable emission-gas-purification engine performance influenced by neither an engine operation condition nor the condition of a catalyst 23 is securable.

[0045] In addition, you may make it change the control period (operation period of the amount AFcomp of amendments (i)) of sub feedback control according to the parameter relevant to the amount of emission, or a catalytic-reaction rate.

[0046] Moreover, you may make it change at least one of the amount of updating of an intermediate objective value, an update rate, the control gain of sub feedback control, a control period, and control ranges using the parameter (however, parameter relevant to an engine operation condition) irrelevant to the amount of emission, or a catalytic-reaction rate.

[0047] Moreover, the downstream exhaust gas sensor 25 may be replaced with an oxygen sensor, an air-fuel ratio sensor (linear A/F sensor) may be used for it, and it may replace the upstream exhaust gas sensor 24 with an air-fuel ratio sensor (linear A/F sensor), and an oxygen sensor may be used for it.

[0048] Moreover, at said each operation gestalt, it is intermediate objective value O2midtarg (i). In case it computes, it is output O2out (i-1) of the downstream exhaust gas sensor 25 at the time of an operation last time. Although used, it is output O2out (i-n) of the downstream exhaust gas sensor 25 in front of the count of a predetermined operation. You may use.

[0049] In addition, this invention is intermediate objective value O2midtarg (i). It cannot be overemphasized that it changes variously that you may change suitably etc. and a formula and the formula of the amount AFcomp of amendments (i) can be carried out.

[Translation done.]

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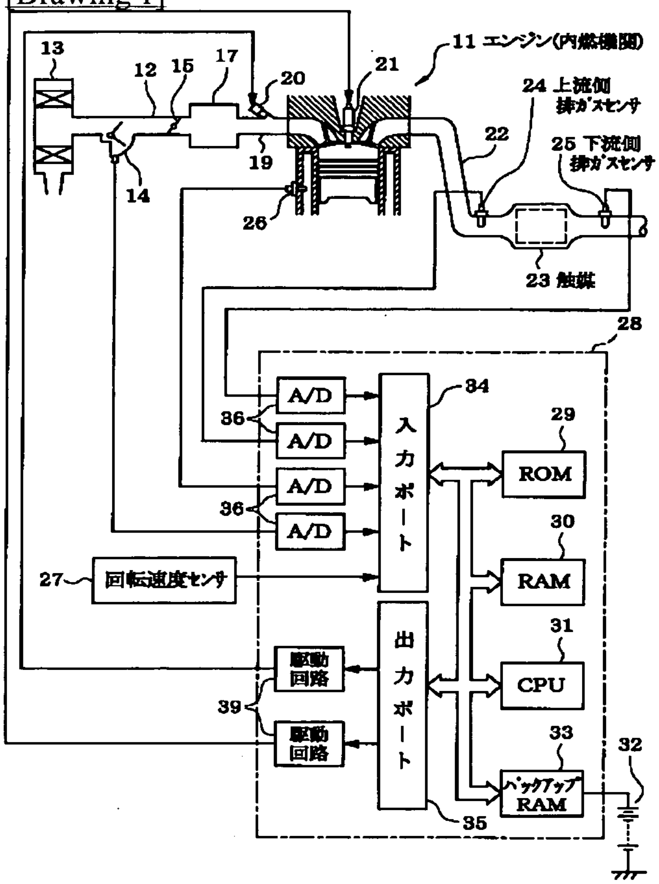
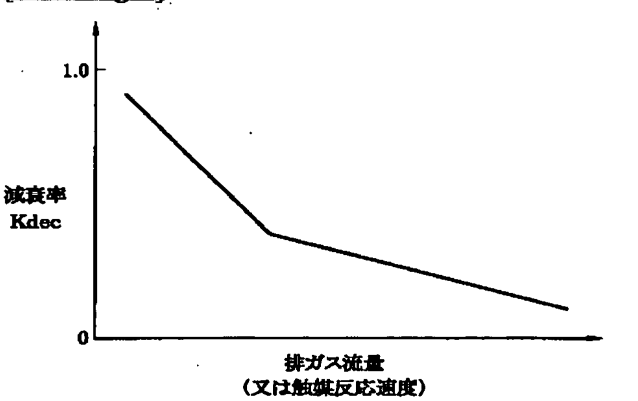
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

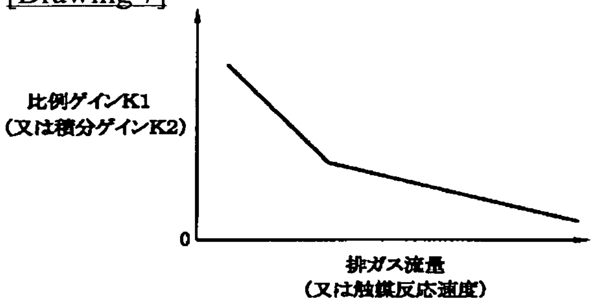
[Drawing 1]



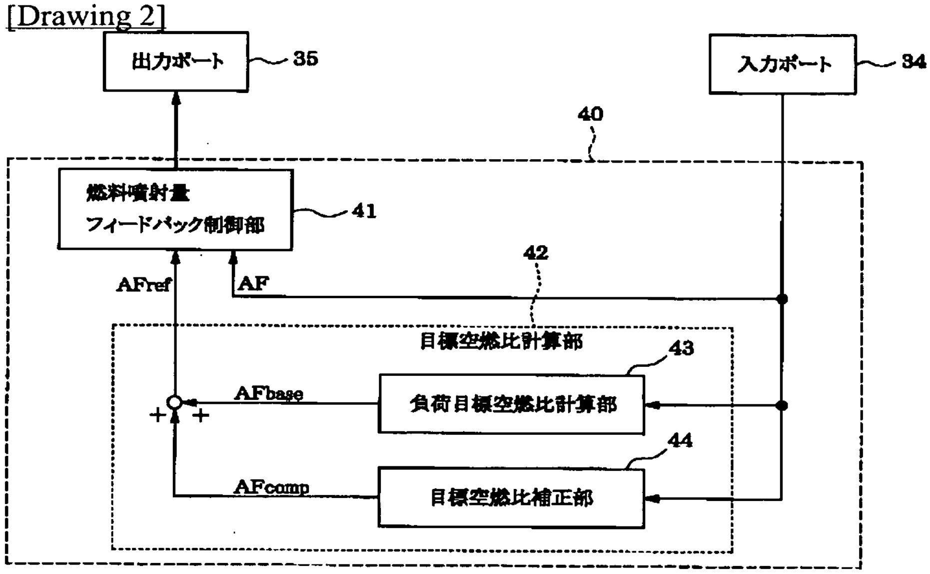
[Drawing 4]



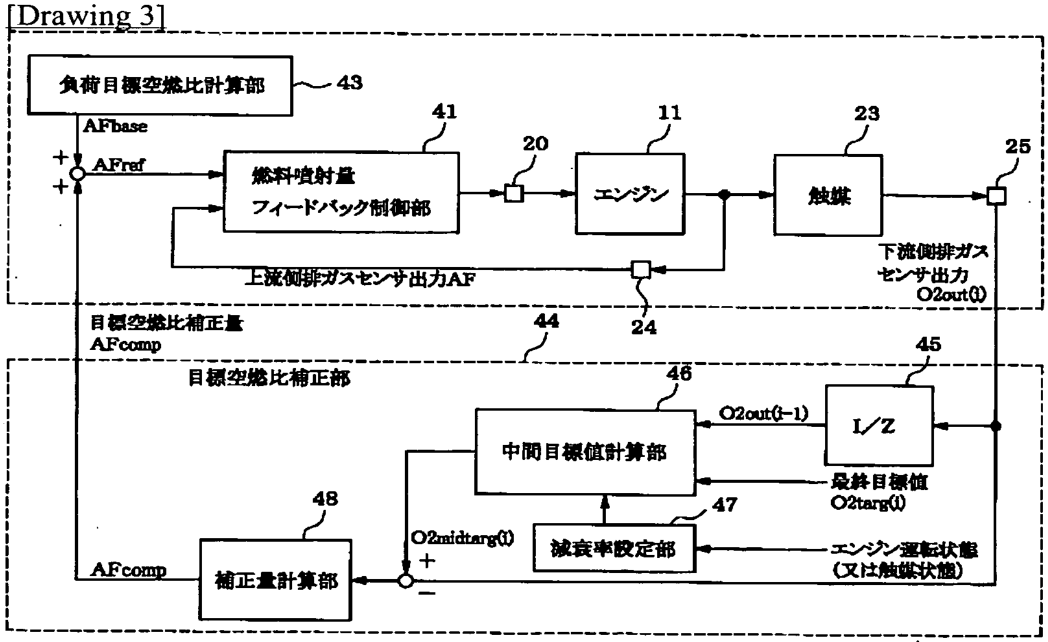
[Drawing 7]



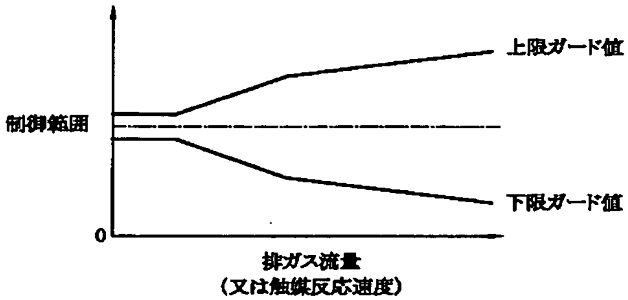
[Drawing 2]



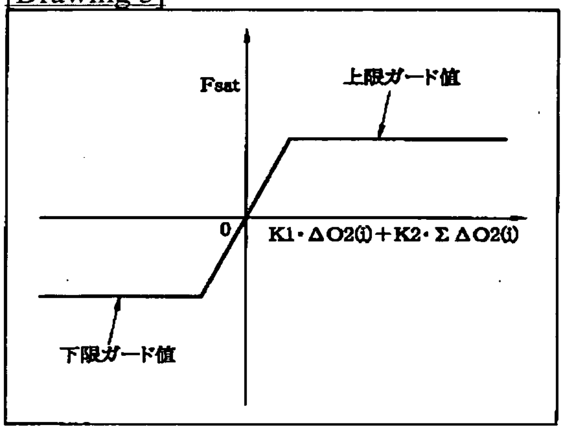
[Drawing 3]



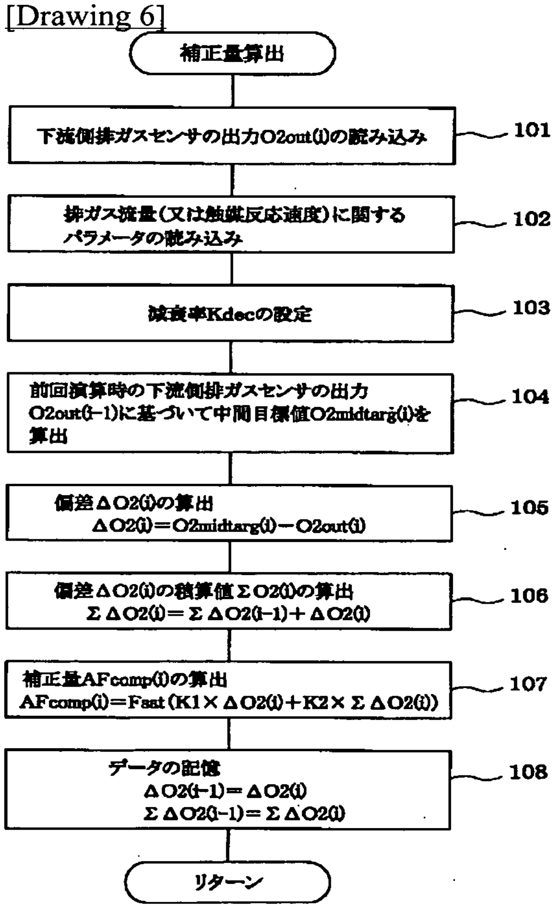
[Drawing 8]



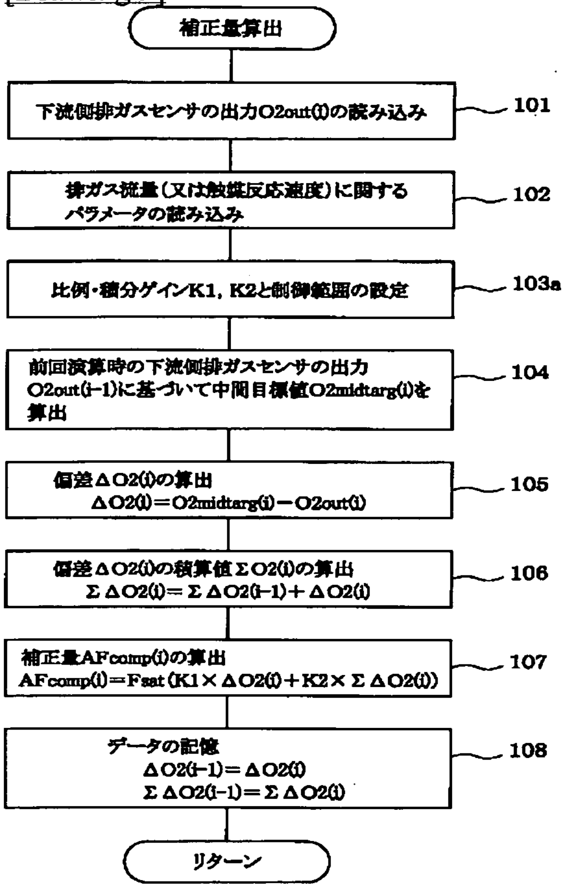
[Drawing 5]



[Drawing 6]



[Drawing 9]



[Translation done.]